

WASHINGTON WATER POWER CLARK FORK RIVER
CABINET GORGE HYDROELECTRIC DEVELOPMENT,
POWERHOUSE
North bank of the Clark Fork River at
Cabinet Gorge
Cabinet
Bonner County
Idaho

HAER No. ID-37-A

HAER
ID
9-CAB,
1A-

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
Columbia Cascades Support Office
National Park Service
909 First Avenue
Seattle, Washington 98104-1060

**HISTORIC AMERICAN ENGINEERING RECORD
WASHINGTON WATER POWER CLARK FORK RIVER
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POWERHOUSE
HAER NO. ID-37-A**

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Location: The north bank of the Clark Fork River at Cabinet Gorge, *Cabinet,*
Bonner County, Idaho, 1,000 feet downstream of the
Montana-Idaho state line.

Date of
Construction: 1951-1953

Engineer: K. O. Strenge, Jr. (Project Engineer)

Builder: Ebasco Services (General Contractor)

Present Owner: Avista Corporation

Present Occupant: Avista Corporation

Present Use: Hydroelectric Generation Facility

Significance: The Cabinet Gorge Powerhouse is locally important
because of its influence, along with the associated Cabinet
Gorge Hydroelectric Development, on the local
environment, landscape and economy. The facility is also
important in the history of the Washington Water Power
Company, now Avista Corporation. The powerhouse
interior equipment represents early 1950s state of the art
technology, now obsolete and soon to be replaced and
upgraded with 1990s technology. The powerhouse was
recommended eligible for inclusion in the National Register
of Historic Places in 1998.

Report
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Date: September 14, 1999

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NOTE: See field notes for figures called out in text.

I. CABINET GORGE ENGINEERS AND CONTRACTORS

The contract for design, purchasing, inspection, construction and accounting for the Cabinet Gorge Hydroelectric Development project was signed between the Washington Water Power Company (now Avista Corporation) of Spokane, Washington, and Ebasco Services Incorporated (Ebasco) of New York, New York, on October 27, 1950. A further "Memorandum of Organization and Procedure" was prepared by Ebasco Assistant Treasurer Mr. G. P. Redden and accepted on behalf of the Washington Water Power Company by Mr. J. E. E. Royer on November 22, 1950. Construction activities started on December 15, 1950, with road construction to the switchyard site. Construction activities were completed on October 1, 1953, when the Ebasco field office was closed (Streng and Searce 1954:1-2).

The dam, powerhouse, switchyard, and their support facilities were designed by the Ebasco Construction Department in New York under the direction of Construction Manager Mr. F. S. Sawyer. Mr. Sawyer organized the field office staff and exercised general supervision over the entire project. The Ebasco field construction organization was headed by Project Manager Mr. B. S. Philbrick. Responsibility for project design and specifications was assigned to Project Engineer Mr. K. O. Streng, Jr. Major equipment purchases for the project were handled by Mr. R. B. Chase of the Ebasco Purchasing Department in New York. Mr. J. A. Riner, Purchasing Agent for the Washington Water Power Company, was the representative with whom the Ebasco field office communicated on all construction matters or allied subjects (Streng and Searce 1954:1-2).

Ebasco performed the erection of equipment, turbines, generators, piping, electrical work and powerhouse furnishing either with its own personnel or through subcontractors. The construction subcontractor on the dam and powerhouse was the Morrison-Knudsen Company. Special construction assistance was provided by the Baldwin-Lima-Hamilton Corporation, General Electric Corporation, and Woodward Corporation.

II. CABINET GORGE POWERHOUSE STRUCTURAL INFORMATION

The Cabinet Gorge Powerhouse is located on the Clark Fork River 1,000' downstream from the Montana-Idaho state line in Bonner County, Idaho. The Cabinet Gorge Powerhouse structure is constructed of reinforced concrete, measures 355' NW-SE and 106' NE-SW and houses four semi-outdoor turbine generators (Streng and Searce 1954:1). The powerhouse is located on a solid rock bluff downstream of the dam on the north bank of the Clark Fork River. Excavation for the powerhouse began at elevation 2,250 and was carried down

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to elevation 2,007 for the lowest point of the Units 2, 3 and 4 draft tubes, and down to elevation 2,000 for the lowest point of the Unit 1 draft tube. During the powerhouse excavation 240,500 cubic yards of rock were removed from the side of the rock bluff. A retaining wall was constructed along the bluff ledge at elevation 2,140 and a fault in the rock structure, known as "C," was excavated to a depth of five feet and sealed with concrete. The powerhouse excavation schedule was as follows (Streng and Searce 1954:26):

Unit #	Excavation Started	Excavation Completed
4	5/29/52	11/4/51
3	8/10/52	12/23/51
2	11/3/52	12/23/51
1	2/22/53	8/15/53

The powerhouse foundation was prepared by injection of 2,773 cubic feet of grout into approximately 7,675 linear feet of holes drilled into the rock subgrade. Half round drains were installed under Units 3 and 4 and weep holes were left under Units 1 and 2 to prevent uplift. Steel reinforcing dowels were used to pin the bottom stage concrete to the rock subgrade and grouting was done at elevation 2,140 to solidify rock behind the powerhouse after placement of the first stage concrete. Placement of foundation concrete began on November 5, 1951, and was completed to above spring runoff level by April 6, 1952. Final placement of powerhouse concrete was completed in 1953. Steel and steel copper strips were used in expansion joints (Streng and Searce 1954:26-27).

The powerhouse roof is set at elevation 2,106 (Ebasco Services 1950). It is constructed of a 4-ply hot mopped membrane felt covered with sisal craft paper and topped with a 3/4" aggregate concrete wearing surface laid in 6' squares. The wearing surface varies from 3" to 5" thick and the surface is sloped to assist drainage. The concrete surface has a hard trowel finish using Lapidolith surface hardener (Streng and Searce 1954:28).

Interior access to the powerhouse is gained through two penthouse stairwells, one located at either end of the roof deck (i.e., the NW end adjacent to Unit 1 and the SE end adjacent to Unit 4). The stairs are of steel construction with Feralun treads and the landings are of reinforced concrete (Streng and Searce 1954:27-28). The penthouse stairwells extend from the roof to the operating floor at elevation 2,091, the pipe gallery at elevation 2,078 and the split access gallery at elevation 2,040 and elevation 2,034 (Ebasco Services 1950).

The interior walls of the powerhouse are made of concrete block, brick or ceramic tile. The walls of the locker room and toilet room have a glazed color

finish. All other walls are finished with plaster, except the interior of the battery room and the closet adjacent to the control booth, which are brick. A variety of paint colors were used for the operating floor interior, including "tropic green" walls, "camellia" generator panels, "harmony green" and "white" tanks and cubicles, "rose petal" columns, "sunlight" and "white" ceilings and "harmony green" doors and trim. Painting was performed by Hunter and Tate from August 1951 to September 1953. Acoustic ceiling tile was hung in the superintendent's office and the original control room (Streng and Searce 1954:28-29).

The powerhouse operating floors and pipe floors are finished with a terrazzo surface, except in the original superintendent's office and the original control room. The terrazzo was laid on a sand cushion covered with tar paper, on which was placed a subgrade of 1 to 4 sand cement mortar. A one-half inch terrazzo chip was then applied to the floor and divided into 3' squares with brass strips. A gray-green color terrazzo was used for the operating floor and a gray-brick color terrazzo was used for the pipe gallery floor. A hornlux floor sealant was used after the final grinding and polishing. The floor of the original superintendent's office and the original control room were finished with gray colored rubber tiles set on concrete and trimmed with a black pre-formed rubber baseboard (Streng and Searce 1954:28).

The powerhouse operating floor and pipe floor interior is lighted by alternating current (AC) fluorescent lights furnished by Gaffney-Kroese Electrical Supply and installed by Ebasco Services Incorporated (Ebasco). Emergency lighting is provided by direct current (DC) incandescent lights located in key areas throughout the powerhouse. Power for the emergency lights is provided by the storage batteries located in the battery room (Streng and Searce 1954:29).

III. CABINET GORGE POWERHOUSE EQUIPMENT TECHNICAL INFORMATION

The primary station control equipment and operating machinery are located on the powerhouse operating floor and the pipe floor (see photographs ID-37-A-1 to ID-37-A-2 and ID-37-A-25 to ID-37-A-28). This equipment and machinery includes the turbines, generators, main control switchboard, turbine governors, oil pressure tanks, sump pumps, station air compressors, station air pressure tanks, generator cooling systems, fire protection systems and central greasing system. All remaining interior equipment dating to the historic period of the powerhouse, 1950-1954, has been photo documented and is described below. In some instances components of the original equipment have been replaced by new components as a result of normal operating use. Note that only one example of duplicated equipment, such as governor housings, turbine pits, and motor control centers, was photographed.

Turbines

The powerhouse contains four hydraulic turbines manufactured by the Baldwin-Lima-Hamilton Corporation of Philadelphia, Pennsylvania. The turbines were purchased by Ebasco for Washington Water Power. The turbines are designated Units 1, 2, 3 and 4, and have the following serial numbers: Unit 1 = #768; Unit 2 = #769; Unit 3 = #770; Unit 4 = #771. All of the units are vertical I. P. Morris propeller type hydraulic turbines rated nominally at 70,500 horsepower (hp) under a 90 foot head with a rotation speed of 120 revolutions per minute (rpm). Unit 1 has adjustable propeller blades and Units 2, 3 and 4 have fixed propeller blades (Baldwin-Lima-Hamilton 1952).

The following table indicates when erection of each unit was started and when each unit went into operation:

Unit #	Erection Started	Operation Date
4	5/18/52	9/29/52
3	7/13/52	11/29/52
2	10/22/52	2/2/53
1	3/26/53	8/15/53

The original Unit 1 Baldwin-Lima-Hamilton turbine was replaced in 1994 because the blades were cracked and worn out. The current kaplan adjustable blade turbine, serial # MB8-390, was manufactured by the Voest-Alpine Machinery Construction Engineering Hydro Turbines and Plants of Linz, Austria. Upon completion of installation the turbine was rated at 120 rpm under a 100 foot head (Voest-Alpine Machinery 1994).

Each unit is equipped with a turbine jacking pump, located within each turbine pit. The jacking pumps are all 1 hp, 1,750 rpm variable speed, 120 volt DC electric motors connected to the central oil system. Each unit is also equipped with a 1/2 hp, 1,140 rpm, 120 volt DC turbine bearing oil pump motor that supplies oil to the turbine bearing during operation. See photographs ID-37-A-3 and ID-37-A-4.

Generators

The Cabinet Powerhouse is equipped with four vertical water-turbine-driven AC generators manufactured by the Westinghouse Electric Corporation and purchased by Ebasco. The generators are designated Units 1, 2, 3 and 4, and have the following serial numbers: Unit 1 = #1S44P58; Unit 2 = #3S44P55; Unit 3 = #2S44P55; Unit 4 = #1S44P55. Each of the four original generators had the

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following specifications: "55,555 kva, .9 pf, 120 rpm, 13,800 volts, 3 phase, 60 cycles, 2,325 amperes" (Streng and Searce 1954:37; Westinghouse 1953). The generators are enclosed under an outdoor type weatherproof metal hood located on the powerhouse roof deck.

Installation of the generators was performed by Ebasco under supervision by Westinghouse field personnel. The following table indicates when erection of each Unit was started and when each Unit went into operation (Streng and Searce 1954:35):

Unit #	Erection Started	Operation Date
4	5/29/52	9/29/52
3	8/10/52	11/29/52
2	11/3/52	2/2/53
1	2/22/53	8/15/53

The Unit 1 generator was rewound in 1994 because the unit had many years of service and the turbine had been replaced. The work was performed by the Westinghouse Electric Corporation. The new stator coils were manufactured by the Westinghouse Toronto plant in Ontario, Canada, and installed by Westinghouse Generation Services. Upon completion of the generator rewind, Unit 1 specifications increased to 66,000 kva; 59,400 kw; 2,761 amps (Westinghouse 1994).

The Unit 2 generator was rewound in 1986 because there was a failure on the winding mechanism. The work was performed by the MagneTek National Electric Coil Redesign Winding of Brownsville, Texas. Upon completion of the generator rewind, Unit 2 specifications increased to 59,000 kva; 53,100 kw; 2,468 amps (MagneTek 1986).

The Unit 4 generator was rewound in 1992 because the unit had many years of service and the turbine had been replaced. The work was performed by the Westinghouse Electric Corporation. The new stator coils were manufactured by the Westinghouse Toronto plant in Ontario, Canada, and installed by Eastern Electric Apparatus Repair Services Company. Upon completion of the generator rewind, Unit 4 specifications increased to 66,000 kva; 59,400 kw; 2,761 amps (Westinghouse 1992).

The generator is cooled by water flow through coils over which air is circulated. The water is taken from the penstock. Water flow control is connected to an

alarm system on the main control switchboard, which sounds if cooling water is insufficient to maintain proper air temperature in the generator barrel (Streng and Searce 1954:38).

Governors

The primary function of a governor is to "maintain the speed of the turbine as close to normal as possible by controlling the amount of water passing through the turbine" (Woodward [1950?]:2). In other words, the governor controls and varies the water flow to the turbines by opening and closing the wicket gates. The governing equipment located at Cabinet Gorge Powerhouse were manufactured by the Woodward Governor Company of Rockford, Illinois. The powerhouse has two twin governors, one which operates turbine Units 1 and 2 and the other which operates turbine Units 3 and 4. Each of these governors is referred to by the manufacturer as "Twin System Cabinet Actuator Governing Equipment," and are "designed to consolidate the actuator, pumping unit, sump tank, pressure tank, piping, and restoring connections" into a compact, easy to operate system (Woodward [1950?]:4). The "Twin System" means that each governor is capable of regulating two turbines. The "governing mechanism and oil pumping units are mounted on fabricated steel sump bases" and the whole assembly is enclosed in one housing cabinet, with all gauges and control devices mounted on the front panel (Woodward [1950?]:4). The actuator houses the governor, valves, and control mechanism (Steve Wenke, personal communications 1999). Cabinet Gorge Powerhouse has combined actuator cabinets with separate governors, valves and control mechanisms for each unit, which control the respective unit servo-motors. The common actuator cabinet provides for a common oil sump and oil pump system. The governor cabinets also house indicators for the generator guide and thrust bearing temperatures, turbine guide bearing temperature and oil pressure and penstock pressure (Streng and Searce 1954:36). See photographs ID-37-A-18 and ID-37-A-19.

Governor Accumulator Tanks

Pressure within the hydraulic fluid system is maintained by high pressure accumulator tanks connected to each governor. Two accumulator tanks are located directly behind each of the governor housings, for a total of four tanks, and each tank regulates hydraulic fluid pressure within one turbine unit. The accumulator tanks were manufactured in 1952 and rated to a maximum working pressure of 300 psi at 650 degrees Fahrenheit. There are four accumulator tanks, with serial numbers 40305, 40303-2, 40304 and 40303-1 for tanks one through four respectively. Accumulator tanks three and four were altered in

1990 by Spokane Metal Products and re-rated to a maximum working pressure of 325 psi at 650 degrees Fahrenheit. The external appearance of the tanks, however, was not changed by the alteration.

Each pair of accumulator pressure tanks were originally serviced by 3 hp, 1,750 rpm, 220/440 volt, 3 phase, 60 cycle, type RPI air compressor motors manufactured by the Wagner Electric Company. The pressure tanks are now serviced by two linked General Electric 5 hp, 220/440 volt type NA-5 air compressor motors, each mounted atop a 350 psi receiver tank. These two General Electric compressors were originally attached to the air circuit breakers in the switchgear rooms on the operating floor. They are now located on the pipe floor, one behind Unit 4 and one behind Unit 2. One of the original compressor motors is still located behind Unit 2 and serves as a back-up compressor. See photographs ID-37-A-2, ID-37-A-13 and ID-37-A-20 to ID-37-A-21.

Main Control Switchboard

The original main control switchboard was manufactured by the General Electric Philadelphia Works, job 32911. The switchboard was manufactured to specification Number W-103-SB, dated February 23, 1951, and revised on July 10, 1951, and September 20, 1951. The specifications called for:

an enclosed switchboard with complete equipment for protection, operation, control, identification and metering for four 50,000 kw, 0.9 pf, 55,555 kva, 3 phase, 60 cycle, 13,800 volt water wheel generators, with grounded neutrals, two banks of three 42,500 kva, 13.2 - 230 kv, 1 phase, 60 cycle transformers, two 1,000 kva, 13,800 - 480 volt, 3 phase, 60 cycle, auxiliary transformers and two 230 kv transmission lines, together with attendant auxiliary apparatus, accessory equipment and materials as may be required for complete self-contained installation, whether or not specifically mentioned in this specification (Ebasco Services 1951:1).

The switchboard cabinet is comprised of 12 sections, identified on sketch TT-9588001 as Units 1 through 12. Unit 1 is a synchronizing control panel; Unit 2 is the general station control panel, which regulates in-plant electrical distribution; Unit 3 is the generator Unit 1 and transformer bank "A" control panel; Unit 4 is the generator Unit 2 control panel; Unit 5 is the generator Unit 3 and transformer bank "B" control panel; Unit 6 is the generator Unit 4 control panel; Unit 7 is a load frequency control panel; unit 8 is a load frequency control panel; Unit 9 is

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the WWP transmission line control panel; unit 10 is the BPA transmission line control panel; and Units 11 and 12 are spare cabinets. Items 2 through 12 are floor standing cabinet sections. Item 1 is not a floor standing cabinet section (General Electric 1952).

The switchboard cabinet is made of enclosed steel duplex stationary panels with steel channel sills and support bracing that form a rigid, self-supporting structure. Switchboard Unit 1 measures 1' 8" wide by 2' 3.5" tall and is attached to the left side of the Item 2 duplex section. The duplex panels of Units 2 through 12 each measure 3' wide and 7' 6" tall, with a 2' 8" tall channel sills. The switchboard has two doors, one at each end, that provide access to the interior. The switchboard cabinet has a pearl gray satin exterior finish and a light gray interior finish. The original instruments, annunciator, relays and meters had a dull black finish. The original instruments and meters also had standard white scales with black numerals and markings. All of the original instruments and meters have since been replaced with lighted digital displays due to equipment failures. Additionally, the equipment was obsolete which made getting parts impossible. All of the major equipment and control circuits are, however, still marked by their original black nameplates with white lettering. See photographs ID-37-A-14 and ID-37-A-15.

Greasing System

The powerhouse is equipped with an automatic centralized, motor driven, adjustable, time clock controlled, forced grease Farval Model DC-25, Series 93-A lubricating system manufactured by the Farval Corporation and purchased under order NY-9033 (Figures 1-2). The greasing system has a Farval Model T4C, Series 5A, 200 pound grease reservoir and is powered by a 1 hp, 220/440 volt, 3 phase, 60 cycle, 1,740 rpm electric motor manufactured by the Reliance Electric Company. The hydraulically operated valves within the system provide for indication and adjustable measuring of the lubrication. The central greasing system originally provided lubrication to 496 points, including the wicket gate arms, within the turbine pits of Units 1, 2, 3 and 4 (Streng and Searce 1954:36). Unit 1, however, no longer requires wicket gate arm greasing since the installation of a new turbine in Unit 1 in 1994. See photograph ID-37-A-13.

Station Air System

The station air system provides air pressure throughout the powerhouse for use in the draft blow down system and the bubbler system that keeps the spillway gates from freezing. The station air system consists of three compressors and four accumulator tanks, also known as receiver tanks, located on the pipe floor between Unit 1 and Unit 2 turbine pits (Figures 3-5). The compressors are Model WBK Duplex Air Compressor units powered by a 200 hp, 440 volt, 3 phase, 60 cycle, 900 rpm electric motor. The compressors were purchased by Ebasco from the Gardner Denver Company (Streng and Searce 1954:39).

The four air accumulator tanks were manufactured in 1952 by the Lang Company. Each tank measures 12' 6" tall by 8' diameter and has a head thickness of 3/4" and a 5/8" shell thickness. The original maximum work pressure of the accumulator tanks was 100 psi at 650 degrees Fahrenheit. The tanks were altered in 1981 by Welk Brothers Metal Products, Inc., and rerated to a maximum work pressure of 125 psi at 650 degrees Fahrenheit. The external appearance of the tanks, however, was not altered. The tanks are currently painted industrial green.

The combined capacity of the compressors is 5,460 cfm and the volume of the receivers is 2,400 cf. The station air system piping consists of a 2" header which serves the blow down system and a 3" header that extends to the dam for operating the bubbler system and anti-ice protection for the gate slots. There are four blow down valves, one for each unit, located on the pipe floor. See photographs ID-37-A-10 and ID-37-A-11.

Fire Protection (high pressure)

Fire protection for the generators is provided by a high pressure carbon dioxide system purchased from the CO TWO Fire Protection Company and installed by Ebasco. The system consists of thirty 100 pound cylinders of carbon dioxide gas located on the pipe floor between Unit 2 and Unit 3 turbine pits (Figures 6-8). The system is controlled by heat detectors within the stator winding and provides for automatic or manual operation, with critical temperature for discharge set at 225 degrees Fahrenheit. When activated, 11 of the cylinders are discharged within 15 seconds and the remaining 19 cylinders sustain the concentration of carbon dioxide within the generator barrel for a 10 minute period (Streng and Searce 1954:38). See photograph ID-37-A-6.

Fire Protection (low pressure)

Station fire protection is provided by low pressure pumping equipment located on the operating floor of the Cabinet powerhouse. The system consists of a 1,000 gallon per minute (gpm) 80 pounds per square inch (psi) single stage Worthington model 4LI pump powered by a 60 hp, 440 volt electric motor (Figures 9-10). A 6" fire line header connected to the pump serves three stations, one each located on the pipe floor, the operating floor and the roof deck. Each station has 150' of canvas fire hose with oil and electrical type fire fighting nozzles stored on racks. The pump was purchased from the Worthington Pump and Machinery Corporation and the piping was installed by Senna Plumbing and Heating (Streng and Searce 1954:39). See photograph ID-37-A-22.

Oil Tanks and Pumps

The central oil lubricating system consists of a lubricating oil pump and a station transil oil pump located in the oil storage room (Figures 11-12). The lubricating oil pump motor is a 3 hp, 1,740 rpm, 3 phase, 60 cycle, 220/440 volt, style OGX motors manufactured by the Lewis Allis Company. A second motor serves as an emergency backup unit for the pump. This unit supplies oil to all systems throughout the powerhouse, including the governors. The transil oil pump is also a 3 hp, 1,740 rpm, 3 phase, 60 cycle, 220/440 volt, style OGX motor manufactured by the Lewis Allis Company. The pumps are connected to two 10' 6" high, 9' diameter, 5,000 gallon capacity lubricating oil storage tanks located in the oil storage room. The oil system piping, consisting of a fill and return line, was installed by Ebasco with locally purchased piping material. A 10' 6" high, 9' diameter, 5,000 gallon capacity fuel oil tank and a 19' 11" long, 9' diameter, 7,000 gallon capacity transformer oil tank are also located in the oil storage room (Streng and Searce 1954:36). See photograph ID-37-A-23.

Bus Room

The Cabinet Gorge Powerhouse is equipped with two interior segregated and isolated phase bus ducts and associated equipment purchased by Ebasco from the General Electric Company of New York. The bus ducts link the generators with the transmission equipment located on the powerhouse roof deck. Each of the two bus ducts and associated equipment are located in the switch gear rooms (also known as bus rooms) were originally composed of the following ten

items: 1) two type ARA, TPST, 4,000 amp, 14.4 kv, 1,500 MVA interrupting capacity air blast circuit breakers for indoor service and 125 volt DC operation, in station type cubicles; 2) one station type cubical housing three lighting arresters and three capacitors (one each per phase for generator surge protection, 3 phase, 13,800 volt), one 14, 400-120 volt, 60 cycle potential transformer (connected to middle phase), one TPST, 600 amp, 15 kv, group operated disconnect switch with key interlock, and one 3,000 amp, 15 kv, segregated bus with interconnections; 3) two potential transformer cubicles each housing, in segregated phase compartments, three draw-out type, 14,400 - 120 volt, 60 cycle potential transformers with fuses; 4) one segregated bus duct cable tap cubical, including bus connections, pot heads and exit bushings for number 6 AWG cable; 5) one 3 phase, 4,000 amp, 15 kv, totally enclosed indoor segregated phase bus duct for connection of generator to air circuit breaker, with cable tap provisions to potential transformer cubical and cable tap cubical for installation in floor trench under cover plate; 6) one segregated bus duct, (same as 5 above) except no provision for cable tap cubical; 7) one 3 phase, 3,000 amp, 15 kv, indoor segregated phase bus duct for interconnection of two air circuit breakers, with provision for bus duct taps to make up delta connections to one bank of three single phase transformers; 8) three single phase, 3,500 amp, 15 kv, indoor segregated phase bus ducts for connection between air circuit breaker interconnecting bus duct and with low tension terminals (item 9 below) of three single phase transformers; 9) six 3,500 amp, 15 kv outdoor isolated phase bus ducts for outdoor section of generator-transformer connections with item 8 (above), including outdoor weather seal; and 10) one air compressor for operation of air blast circuit breakers (item 1 above) complete with storage tank, receivers, after-cooler, and dryer, all standard arranged for automatic sequential starting to meet pressure requirements, including selector switch for transfer to initial starting from one compressor to the other. The potential transformers are also connected to the main switchboard for control and monitoring of generator output. The bus duct housings and equipment remain original, except for the air blast circuit breakers and compressors, potential transformers, and generator surge protection, which were replaced in the late 1980s. The air blast circuit breaker compressors are now connected to the governor oil pressure tanks. See photograph ID-37-A-16.

Power and Load Centers

Station electrical service is provided through two identical General Electric 440 volt power centers that are supplied from the 1,000 kva auxiliary transformer and remote controlled from the main switchboard. These two virtually identical power centers, located on the operating floor, feed three General Electric load centers, two located on the operating floor and one located on the pipe floor.

Each of the load centers are rated at 600 volts, 60 cycle, 3 phase, using 3 wire circuits. The power centers and load centers control lighting panels, distribution panels, and motor and feeder circuits throughout the powerhouse, dam and switchyard. The power centers and motor control centers were purchased by Ebasco from General Electric (Streng and Searce 1954:42). See photographs ID-37-A-8, ID-37-A-17 and ID-37-A-21.

Station Control Batteries

The station control batteries furnish DC power for emergency lighting and for starting and control of station facilities in the event of complete electrical power outage within the powerhouse. The powerhouse was originally equipped with 60 Exide-Manchex type FME electric storage batteries stored in the battery room on the operating floor. The batteries were charged by a CR-7501-K114D22 floor mounted self-regulating Phano-Charger (Figure 13). The Phano-Charger automatically maintained batteries at a preselected power level. The storage batteries were supplied by the Electric Storage Battery Company of Philadelphia, Pennsylvania, and Phano-Charger was supplied by Control Department of the General Electric Company, Schenectady, New York, under Ebasco (Streng and Searce 1954:42-43).

The 60 Exide-Manchex batteries were replaced in 1971 with 60 KCU-7 lead calcium batteries manufactured by C&D Batteries, a Division of Eltra Corporation, Conshohocken, Pennsylvania. The Phano-Charger battery charger was replaced as primary battery charger in 1971 with a 208/40/480 AC volt, 40/35/17.5 AC amp, 1 phase, 60 hertz, 132 DC volt, 50 DC amp, Model ARE130CE50F battery charger manufactured by C&D Charter Power Systems, a division of Eltra Corporation, Plymouth Meeting, Pennsylvania. The original Phano-Charger is now used as a back-up battery charger. The battery chargers are located on the operating floor adjacent to the battery room. See photograph ID-37-A-24.

Station Unwatering Pumps and Sump Pumps

The unwatering system and low level drainage system consists of three pumps (two unwatering pumps and one station pump) for each pair of turbine units (i.e., Units 1 & 2 and Units 3 & 4 each share a set of three pumps), for a total of six pumps. The turbine draft chest drains into the sump and the water then is pumped from the sump utilizing the unwatering pumps. The four unwatering pumps are deep well turbine pumps, each powered by a 200 hp, 1,200 rpm, 440 volt, 3 phase, 60 cycle, type CFU electric motor (Figure 14). The station sump

pumps are used for normal drainage and consist of two deep well type turbine pumps powered by 50 hp, 1,475 rpm, 220/440 volt, 3 phase, 60 cycle, type QZKV electric motors. The pumps were purchased by Ebasco from the Fairbanks Morse Company under contract NY-9042 (Streng and Scarce 1954:39). See photographs ID-37-A-2 and ID-37-A-5.

Service Water System and Cooling Water System

The service water system supplies water to each unit's stuffing box, air coolers, fire pump, to hose bibs for flushing, and for compressor cooling. The system consists of a 12" line with connections to each of the four turbine penstocks. The water passes through 12" Andale Type 101 Duplex Cast Iron Strainers with a capacity of 1,500 gpm with a one pound pressure drop from 125 psi normal operating pressure. A 1/2" line supplies water for cooling the turbine guide bearing stuffing box and a 3" line supplies water for cooling the generator thrust bearing. Duplex arrangement permits servicing while in use. The system was installed by Smyth Plumbing and Heating Company (Streng and Scarce 1954:36, 40). See photograph ID-37-A-7.

Water Purification System

Potable water for the powerhouse is obtained from the reservoir pond and purified by a domestic water treatment system located on the pipe floor across from Unit 3 turbine pit. The treatment system consists of a Culligan water chlorination treatment and filtration system, with attached pressure tank and pump motor, purchased by Ebasco from the Permutit Company. The potable water is then piped throughout the powerhouse and provides service to water coolers and washrooms (Streng and Scarce 1954:30). See photograph ID-37-A-9.

Sewage Ejector Pumps

The powerhouse has two sewage ejector pumps that transfer sewage from the powerhouse to the station septic system. The pumps are located on the pipe floor adjacent to the Unit 1 turbine pit and across from the station air receivers. Each of the two pumps is a Yomans Series 8,000 Duplex Screenless Ejector capable of 100 gpm powered by a 1 hp, 1,115 rpm, 440 volt, 3 phase, 60 cycle electric motor. The ejector pumps and motors were manufactured by the Yomans Brothers Company, Chicago, Illinois. See photograph ID-37-A-12.

IV. HISTORICAL INFORMATION

Cabinet Gorge Dam is located east of Lake Pend Oreille at Cabinet Gorge on the Clark Fork River in Bonner County, Idaho, near the Montana border. Feasibility studies of Cabinet Gorge as a site for power development were conducted in the late 1940s by Washington Water Power (WWP), the Army Corps of Engineers (ACOE) and the Department of the Interior (DOI). These power development studies were prompted by the increasing shortage of peaking power in the Upper Northwest. By 1948, peaking power was so short that voluntary conservation measures were undertaken throughout the region (Blewett 1989:41). With this need for more power, also came increased competition for satisfying that power need. Public and private utilities vied for the same facility sites, including Cabinet Gorge. The WWP company was one of those companies. But WWP was also in a fight for its very survival as a company as it looked for ways to expand and meet the growing power demands of the Northwest.

By late 1949, WWP was in danger of being sold or dismembered by its parent holding company, American Power & Light (AP&L). After replacing the entire WWP board of directors, except WWP President Kinsey M. Robinson, AP&L began secret negotiations with several public utilities for the sale of WWP assets (Blewett 1989:43). Only a temporary restraining order initiated by Robinson prevented AP&L from selling Washington Water Power. Prompt action was needed if WWP was to remain solvent. The failure of Congress to act on a DOI comprehensive plan for development of the Columbia River Basin, including Cabinet Gorge, presented WWP with an opportunity for salvation. Ebasco of New York was retained by WWP early in 1950 to devise a feasible plan for construction of a hydroelectric facility at Cabinet Gorge (Streng and Searce 1954:1). Ebasco presented WWP with a contract for design, purchasing, inspection, construction and accounting in October 1950. The WWP company filed for a license to build a dam at Cabinet Gorge with the Federal Power Commission (FPC) [predecessor of the Federal Energy Regulatory Commission] in November 1950.

Two months after WWP filed for a license to build a dam at Cabinet Gorge the FPC granted the license. It was one of the fastest license application decisions ever rendered by the FPC (Blewett 1989:44) primarily due to the demand and need for the service. Construction activities associated with the dam were under way by February 1951. These activities included not only construction of the dam, but also the relocation of sections of the Northern Pacific Railroad (now Burlington Northern Santa Fe), US Highway 10-A (now Montana Highway 200),

some county and Forest Service roads and the removal of timber within the future reservoir area. Even portions of the town of Noxon had to be raised because of the project.

Ebasco was the primary contractor for the project. An aggressive 24 hour work schedule for the project was promptly adopted. The site required that construction work on the dam, at least up to spillway height, be completed between spring runoff periods. Cofferdams and bypass tunnels were completed eight months after the construction license was issued. The task of synchronization of highway, railroad and county road relocation with reservoir work and construction of the dam was enormous. Construction activities continued in three shift rotations regardless of weather and completion of construction of the dam to safe elevation was accomplished between successive high waters of 1951 and 1952.

Meanwhile, the issue of WWP ownership was being resolved. The AP&L company had lost the option of selling WWP because of the injunction. After the case was tried in March 1952, and the pending sale of WWP to a public utility was declared illegal, AP&L moved to form a new board of directors for WWP (Blewett 1989:43). Kinsey Robinson retained presidency of the WWP. In April 1952, the board voted for distribution of WWP stock to AP&L shareholders, an idea that had been rejected by AP&L in 1949. This action made WWP independent of financial direction from New York after more than 50 years of AP&L oversight.

Six months after receiving independence, WWP had more good news. It was ready to bring the newly finished Cabinet Gorge hydroelectric plant on-line. The first of four 50 MW generators went on-line at Cabinet Gorge Dam on September 30, 1952. The WWP company accomplished the task of bringing the power plant on-line at Cabinet in less than two years from the issue of the FPC construction license.

Cabinet Gorge Dam and its associated reservoir have had a significant impact on the local economy and development of both Bonner County, Idaho, where the dam is located and Sanders County, Montana, where most of the reservoir is located. The reservoir forced the physical reshaping of Sanders County, including the alteration of the highway and railroad transportation routes in the Clark Fork valley. The reservoir has also helped make the region into a popular recreational and fishing area. Washington Water Power is a major part of the Bonner and Sanders County tax base. Washington Water Power provides high income jobs in the region both directly and indirectly associated with Cabinet Gorge Dam. The dam also supplies power to the northern Idaho region.

The site is also a significant engineering accomplishment. The dam was constructed in less than two years under difficult conditions. Though the dam and powerhouse architecture are relatively common, the engineering and logistical obstacles overcome during the 20 month construction time is uncommon. These obstacles included not only construction of the powerhouse itself, but also relocation of the highway, county roads and railroad, the elevating of portions of the town of Noxon, clearing trees from the reservoir area and weather.

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